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# NANOPARTICLE STANDARDS

OFFICE OF NONPROLIFERATION AND ARMS CONTROL (NPAC)

INTERNATIONAL NUCLEAR SAFEGUARDS

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## Benefit

- **This approach creates particle-like deposits of known mass in known locations**
- The long term goal is to develop a hybrid deposition methodology utilizing nanoparticle solutions to create deposits of known atomic composition, in known locations separated by 10-20 micrometers.

## Applications

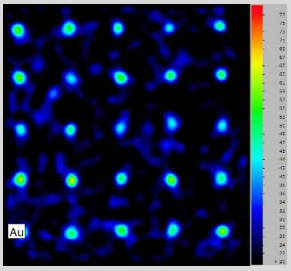
- Creation of custom particle standards for IAEA laboratories in addressing calibration of spatially resolved instrumentation in the characterization of particulate matter for safeguards applications

## Project Description

We will purchase a COTS materials printer and adapt it for solution printing of known elemental concentration solutions. A methodology will be developed to create deposits of known mass in known locations on selected substrates. The deposits will be characterized for deposited mass, physical morphology, thickness and uniformity. Once an acceptable methodology has been developed and validated, we will create round robin samples to be characterized by LGSIMS instruments at LANL, PNNL and NIST. We will demonstrate the feasibility of depositing nanoparticles in known masses with the goal of creating separated nanoparticles in known locations.

## Current Capabilities (TRL-4)

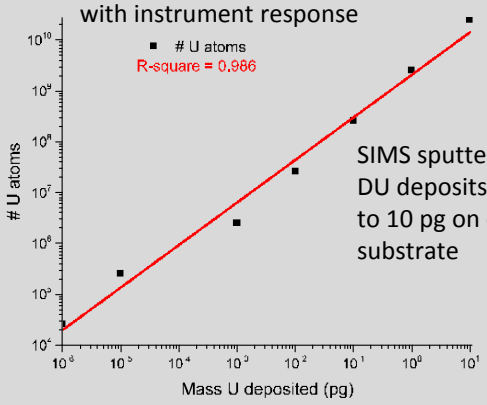
- Evaluate and purchase the Dimatix printer
- Modify and develop printing methodology for solution based deposits.
- Test deposit methodology with round robin samples analyzed by LG SIMS at PNNL, LANL and NIST
- Test feasibility of nanoparticle deposition using inkjet printer




XRF image of 10 pg deposits of gold on silicon substrate in a 5 x 5 array, 500 µm separation

Picture of Dimatix 2850 materials printer

Expected linear correlation of deposited mass with instrument response




SIMS sputter analysis of DU deposits from 10 fg to 10 pg on carbon substrate

***Preliminary test deposits of gold, 10 pg using the proposed Dimatix materials printer. Plot shows anticipated linear correlation of DU from 10 fg to 10 pg using LG SIMS sputtering to measure the deposits***

## Anticipated Final Capabilities

The final prototype will have the following:

- Creation of custom composition and isotopic particle standards to calibrate instrument response for unknown particle characterization
- Ultimate goal is to develop a 'cookbook' methodlogy to enable other labs to create their own standards on demand using this printer

## Further Reading

1. Novel Calibration Approach for Sensitive Isotopic Nuclear Material Characterization using Thermal Inkjet Pico-fluidic System (TIPS) and Femtosecond Laser Ablation Time of Flight Mass Spectrometry (fs-LA-ICP-TOF-MS), G. J. Havrilla, K. G. McIntosh, J. J. Gonzalez, D. D. Oropeza, M. Morey, R. E. Russo, submitted to JAAS 2016
2. Picoliter Droplet Deposition Using a Prototype Picoliter Pipette: Control Parameters and Application in Micro X-ray Fluorescence, Ursula E. A. Fittschen and George J. Havrilla, Analytical Chemistry, 82, 1, 2010 297
3. Picoliter solution deposition for total reflection X-ray fluorescence analysis of semiconductor samples, Chris M. Sparks, Ursula E.A. Fittschen, George J. Havrilla, Spectrochimica Acta Part B 65 (2010) 805–811

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